Assisting the automation industry since 1986

User manual
TEMPERATURE TRANSMITTER
SPT-61

- Firmware: v.1.07 or higher
- Input type: Pt100/500/1000
- Pt100/500/1000 / 4-20 mA signals transmitter

Read the user's manual carefully before starting to use the unit or software.
Producer reserves the right to implement changes without prior notice.

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Explanation of symbols used in the manual:

- This symbol denotes especially important guidelines concerning the installation and operation of the device. Not complying with the guidelines denoted by this symbol may cause an accident, damage or equipment destruction.

IF THE DEVICE IS NOT USED ACCORDING TO THE MANUAL THE USER IS RESPONSIBLE FOR POSSIBLE DAMAGES.

- This symbol denotes especially important characteristics of the unit. Read any information regarding this symbol carefully

1. BASIC REQUIREMENTS AND USER SAFETY

- The manufacturer is not responsible for any damages caused by inappropriate installation, not maintaining the proper environmental conditions and using the unit contrary to its assignment.

- Installation should be conducted by qualified personnel . During installation all available safety requirements should be considered. The fitter is responsible for executing the installation according to this manual, local safety and EMC regulations.

- The unit must be properly set-up, according to the application. Incorrect configuration can cause defective operation, which can lead to unit damage or an accident.

- **If in the case of a unit malfunction there is a risk of a serious threat to the safety of people or property additional, independent systems and solutions to prevent such a threat must be used.**

- Neighbouring and connected equipment must meet the appropriate standards and regulations concerning safety and be equipped with adequate overvoltage and interference filters.

- **Do not attempt to disassemble, repair or modify the unit yourself. The unit has no user serviceable parts. Defective units must be disconnected and submitted for repairs at an authorized service centre.**

The unit is designed for operation in an industrial environment and must not be used in a household environment or similar.

2. GENERAL CHARACTERISTICS

The **SPT-61** module is equipped with Pt 100/Pt 500/Pt 1000 type input, with automatic connection recognition (three or two wire sensor). The measurement range spans from -100 °C to +600 °C, and input is fully linearised according to PN-EN60751+A2:1999 standard. Measurement value is transmitted to the current loop output (4-20mA) directly after recalculation according to scale selected by user. The device configuration may be done via build in serial interface (USB or RS-232/TTL) with Modbus RTU protocol. Every unit can be factory pre-configured on request.

3. TECHNICAL DATA

Power supply voltage (Us) Current consumption	9.5...**24**...36V DC (not separated) max. 3.7 mA (while configuration – supplied from serial interface)
Measurement input	Pt 100/ Pt 500/Pt 1000 type (2 or 3-wires, automatic connection recognition)
Measurement range	-100°C ÷ +600°C
Measurement accuracy	± 0.2% (@ 25°C)
Temperature coefficient	0.01% / °C
Internal resolution	0.1°C
Measurement wires resistance	max. 20 Ω
Passive current output	range max. 3.4 ÷ 24 mA, load resistance 0...(Us - 9.5V) / 24mA [kΩ]
Resolution of output converter	12 bits
Communication interface (depending on version)	USB (Virtual Communication Port) or RS-232/TTL, 8N1 and 8N2, Modbus RTU, not separated
Baud rate	9600 bit/s
Data memory	non-volatile memory, EEPROM type

Protection level	IP 20
Housing type Housing dimensions	DIN rail mounted (35 mm rail) 80 x 97 x 7 mm
Operating temperature (depending on version)	0°C to +50°C or -20°C to +50°C
Storage temperature (depending on version)	-10°C to +70°C or -20°C to +70°C
Humidity Altitude	5 to 90% no condensation up to 2000 meters above sea level
Screws tightening max. torque	0.5 Nm
Max. connection leads diameter	2.5 mm^2
EMC	according to: PN-EN 61326-1

This is a class A unit. In a residential or a similar area it can cause radio frequency interference. In such cases the user can be requested to use appropriate preventive measures.

4. DEVICE INSTALLATION

The unit has been designed and manufactured in a way assuring a high level of user safety and resistance to interference occurring in a typical industrial environment. In order to take full advantage of these characteristics installation of the unit must be conducted correctly and according to the local regulations.

- Read the basic safety requirements on page 2 prior to starting the installation.
- Ensure that the power supply network voltage corresponds to the nominal voltage stated on the unit's identification label.
- The load must correspond to the requirements listed in the technical data.
- All installation works must be conducted with a disconnected power supply.

4.1. UNPACKING

After removing the unit from the protective packaging, check for transportation damage. Any transportation damage must be immediately reported to the carrier. Also, write down the unit serial number on the housing and report the damage to the manufacturer.

Attached with the unit please find:
- user's manual,
- warranty,

4.2. ASSEMBLY

- Disconnect the power supply prior to starting assembly.
- Check the connections are wired correctly prior to switching the unit on.

4.3. CONNECTION METHOD

Caution

- Installation should be conducted by qualified personnel . During installation all available safety requirements should be considered. The fitter is responsible for executing the installation according to this manual, local safety and EMC regulations.

- Wiring must meet appropriate standards and local regulations and laws.

- In order to secure against accidental short circuit the connection cables must be terminated with appropriate insulated cable tips.

- Tighten the clamping screws. The recommended tightening torque is 0.5 Nm. Loose screws can cause fire or defective operation. Over tightening can lead to damaging the connections inside the units and breaking the thread.

- In the case of the unit being fitted with separable clamps they should be inserted into appropriate connectors in the unit, even if they are not used for any connections.

- Unused terminals (marked as n.c.) must not be used for connecting any connecting cables (e.g. as bridges), because this can cause damage to the equipment or electric shock.

Due to possible significant interference in industrial installations appropriate measures assuring correct operation of the unit must be applied. To avoid the unit of improper indications keep recommendations listed below.

– Avoid running signal cables and transmission cables together with power supply cables and cables controlling inductive loads (e.g. contactors). Such cables should cross at a right angle.

– Contactor coils and inductive loads should be equipped with interference protection systems, e.g. RC-type.

– Use of screened signal cables is recommended. Signal cable screens should be connected to the earthing only at one of the ends of the screened cable.

– In the case of magnetically induced interference the use of twisted pair of signal cables is recommended. Twisted pair (best if shielded) must be used with RS-485 serial transmission connections.

– In the case of interference from the power supply side the use of appropriate interference filters is recommended. Bear in mind that the connection between the filter and the unit should be as short as possible and the metal housing of the filter must be connected to the earth with the largest possible surface. The cables connected to the filter output must not be run with cables with interference (e.g. circuits controlling relays or contactors).

Connections of power supply voltage and measurement signals are executed using the screw connections on the back of the unit's housing.

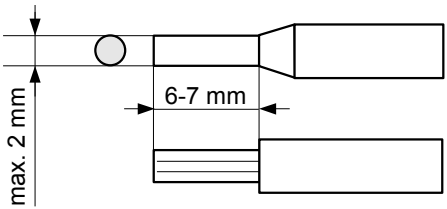


Figure 4.1. Method of cable insulation replacing and cable terminals

- All connections must be made while power supply is disconnected !

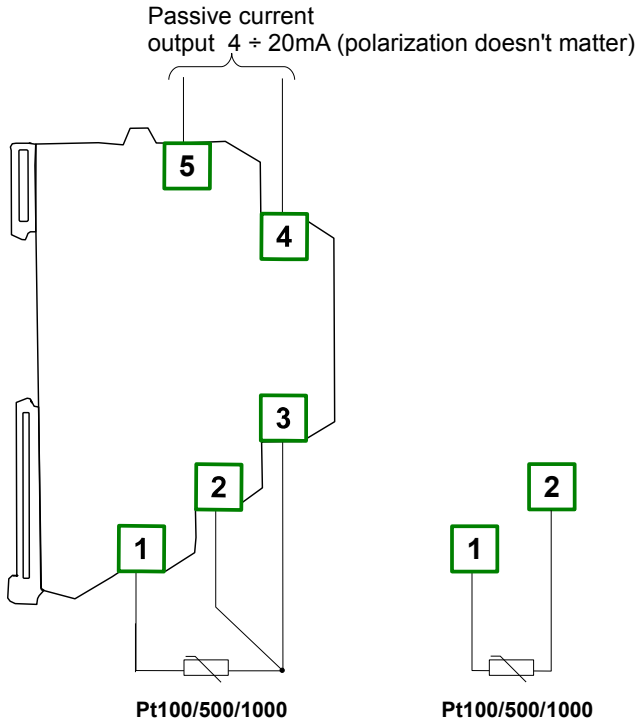


Figure 4.2. Terminals description

Temperature sensor can be connected to the device in typical 3-wire circuit (Figure 4.3a) or 2-wire circuit (Figure 4.3 b). Due to precision of measurement 3-wire circuit is recommended.

If 2 wire circuit is used, the resistance of wires should be as small as possible, to avoid of measurement errors. Measured value can be corrected (constant correction) using „**InputOffset**" parameter available in group of registers called „**Input**". Due to low precision 2-wire connection is not recommended.

When 2-wires connection is used, the resistance of particular wires (Ra, Rb) **CAN BE DIFFERENT**. When 3-wires connection is used, the resistance of particular wires (Ra ÷ Rc) **MUST BE IDENTICAL** to enable proper compensation of it's resistance. The resistance of particular wire **should not be greater than 20 Ω.**

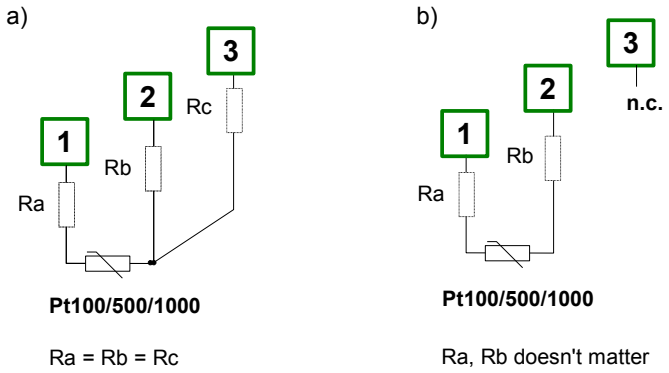


Figure 4.3. Connection of sensors:
a) 3-wires circuit; b) 2-wires circuit;

The connection circuit should not be changed while unit is powered. Every change of connection while the unit is powered causes measurement errors by several seconds after change.

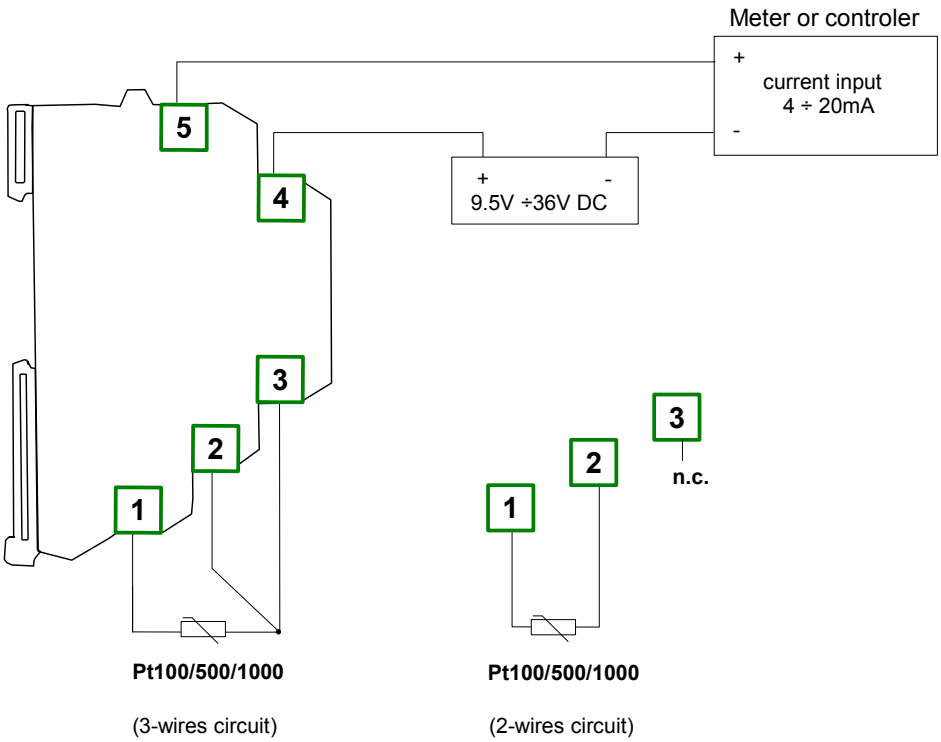


Figure 4.4. Example of current outputs connection

4.4. MAINTENANCE

The unit does not have any internal replaceable or adjustable components available to the user. Pay attention to the ambient temperature in the room where the unit is operating. Excessively high temperatures cause faster ageing of the internal components and shorten the fault-free time of the unit's operation.
In cases where the unit gets dirty do not clean with solvents. For cleaning use warm water with small amount of detergent or in the case of more significant contamination ethyl or isopropyl alcohol.

Using any other agents can cause permanent damage to the housing.

Product marked with this symbol should not be placed in municipal waste. Please check local regulations for disposal of electronic products.

5. PRINCIPLE OF OPERATION

SPT-61 module allows conversion from temperature (PT100) to the current value in 4-20mA standard. Present value of temperature is available as measurement register of device (reg. addr. 01h). If input signal exceeds the permissible range, shortcut or break of measurement circuit occur, appropriate bit of ***status register*** (register 02h) will be set. This bit signalise exceeding of ***permissible measurement range***. Configuration registers are available via serial interface

Parameters referred to measurement input can be found in group of registers called „**Input**" (see ***LIST OF REGISTERS***) and allows:

- selection of input type („**InputType**" parameter)
- change of filtration rate of values returned in measurement register („**InputFilter**" parameter)
- offsetting of the measurement scale („**InputOffset**" parameter)

The way of conversion from temperature measurement result to the current value is described by parameters which can be found in group of registers named „**Output**" (see ***LIST OF REGISTERS***).

Current output can be controlled depend on present measured value (01h register) or peak value (06h register, if peak detection is enabled).

"OutMode" parameter determines operation mode of the output. Current output can be controlled by present temperature value (*"**4-20**"* mode**)** or fixed to value written by user (to the 05h register) using serial interface (*"**modbus**"* mode).
In *"**4-20**"* mode "**OutLow**" parameter determines the temperature value for which the output current equals 4 mA and "**OutHigh**" parameter determines the temperature value for which the output current equals 20mA.

The output current value is calculated due to formulas given below:

$$I_{out} = \frac{T - "OUtL"}{"OUtH" - "OUtL"} \times 16\,mA + 4\,mA$$

where "**T**" denotes the temperature value.

"**OutLow**" parameter can be greater than "**OutHigh**". In this case the conversion characteristic is reversed, it means that if input value raises the output current falls.

"**OutLoRange**" and "**OutHiRange**" parameters define the output current range (maximum range 3.6 to 24 mA). If calculated output value $\mathbf{I_{out}}$ exceeds defined range then current output generates the current equal to upper or lower border of the defined range. The parameters define the percentage extension of nominal current range 4-20 mA (with 0,1% resolution). Parameter "**OutLoRange**" defines lower border of the range due to formula:

$\mathbf{I_{min}}$ = 4 mA - 4 mA × "**OutLoRange**" %

This parameter can be set from 0 to 9.9%. Parameter **"OutHiRange"** defines lower border of the range due to formula:

$\mathbf{I_{max}}$ = 20 mA + 20 mA × "**OutHiRange**" %

This parameter can be set from 0 to 19.9%.

„**OutAlarm**" parameter determines the behaviour of current output if any critical situation occurs (exceeding of ***permissible measurement range***, shortcut or break of measurement circuit). In this case output current will not change or will be set to the user selected value (depending on „**OutAlarm**" parameter).

- Occurrence of critical situation is signalised by flashing red LED (**ALARM**) on front panel.
- When the critical situation goes, the current will be set to value calculated due to formulas given above.

Device parameters are stored in nonvolatile EEPROM memory. All available device parameters can be set via serial interface (see ***LIST OF REGISTERS*** at page 11).

5.1. DETECTION OF THE PEAK VALUES

The **SPT-61** module is equipped with peaks detection function. It can detect a peaks of the input signal and hold their values. Presets connected with this function are placed in group of registers named **"Hold"** (see ***LIST OF REGISTERS***). The detection of the peak can be done if the measured signal raises and drops of value at least equal to parameter **"HoldPEA"**. Detected peaks are hold during the time defined by parameter **"HoldTime"**. If a new peak will be detected while one is hold, this new peak will be held and value holding time counter will restarted (Figure 5.1). If no peaks are detected while time **"HoldTime"** elapses**,** device returns the current value of input signal in the peak value register (06h register).

The current output can be controlled depending on the current value of input signal (01h register) or the peak value (06h register, see ***LIST OF REGISTERS***).

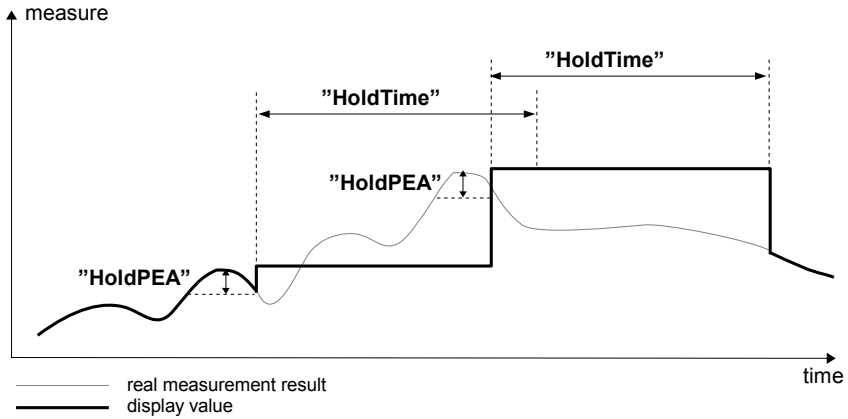


Figure 5.1. Process of peaks detection

6. THE MODBUS PROTOCOL HANDLING

Transmission parameters: 1 start bit, 8 data bits, 1 or 2 stop bit (2 bits are send, 1 and 2 bits are accepted when receive), no parity control
Baud rate: 9600 bits/second
Transmission protocol: MODBUS RTU compatible

The device parameters and display value are available via RS-485 interface, as HOLDING-type registers (numeric values are given in U2 code) of Modbus RTU protocol. The registers (or groups of the registers) can be read by 03h function, and wrote by 06h (single registers) or 10h (group of the registers) accordingly to Modbus RTU specification. Maximum group size for 03h and 10h functions can not exceeds 16 registers (for single frame).

The device interprets the broadcast messages, but then do not sends the answers.

6.1. LIST OF REGISTERS

Register	*Write*	*Range*	*Register description*
01h	No	-999 ÷ 6000	Measurement value (no decimal point)
02h	No	0h, A0h, 60h	The status of the current measurement; **0h** - data valid; **A0h** - top border of the measurement range is exceeded; **60h** - bottom border of the measurement range is exceeded;
03h	No	1	Decimal point position, constant value: **1** - " **0.0**";
04h	Yes	see descr.	State of the alarm LED (binary format) (1 - on, 0 - off)
05h	Yes	0h ÷ 1800h	State of current output, expressed in 1/256 mA units – it means that high byte express integer part, and low byte fractional part of desired output current.
06h	No	-999 ÷ 6000	Peak (drop) value (no decimal point)
„Input" registers group			
10h	Yes	0 ÷ 2	"**InputType**" parameter (input type). **0** - Pt-100; **1** - Pt-500; **2** - Pt-1000
12h	Yes	0 ÷ 5	"**InputFilter**" parameter (measurement filtering rate)
13h	No	1	Decimal point position, constant value: **1** - " **0.0**";
18h	Yes	-99 ÷ 99	"**InputOffset**" parameter (shift of measurement scale), expressed by 0,1°C
„Modbus" registers group			
20h	No	1	Device address of the device, accordingly to Modbus protocol.
21h	No	2061h	Device identification code (ID)
„Hold" registers group			

Register	Write	Range	Register description
50h	Yes	0 ÷ 1	"**HoldMode**" parameter (type of detected changes): **0** - peaks, peak and next drop of the input signal of value equal at least **"PEA"**; **1** - drops, drop and next peak of the input signal of value equal at least **"PEA"**;
51h	Yes	0 ÷ 9999	"**HoldPEA**" parameter, no decimal point included (minimal detected signal change classified as peak or drop, see Figure 5.1)
52h	Yes	1 ÷ 199	"**HoldTime**" parameter, maximum peaks' (or drops') display time expressed in 0.1 second
58h	Yes	0 ÷ 1	"**HoldOut**" parameter (current output operation mode): **0** - driven by present measured value (from 01h register); **1** - driven by peak/drop value (from 06h register)
„Output" registers group			
A0h	Yes	0 ÷ 1	"**OutMode**" parameter (current output mode) **0** - current output value in 4÷20mA mode depends on measured value (by 01h or 06h register); **1** - current output controlled via serial interface (by 05h register)
A1h	Yes	-999 ÷ 9999	"**OutLow**" parameter, no decimal point included
A2h	Yes	-999 ÷ 9999	"**OutHigh**" parameter, no decimal point included
A3h	Yes	0 ÷ 99	"**OutLoRange**" parameter, expressed in 0.1%
A4h	Yes	0 ÷ 199	"**OutHiRange**" parameter, expressed in 0.1%
A5h	Yes	0 ÷ 2	"**OutAlarm**" parameter (current output value on critical exception): **0** - no change; **1** - 22.1 mA; **2** - 3.4 mA

6.2. TRANSMISSION ERRORS DESCRIPTION

If an error occurs while write or read of single register, then the device sends an error code according to Modbus RTU specifications (example message no 1).

Error codes:
01h - illegal function (only functions 03h, 06h and 10h are available),
02h - illegal register address
03h - illegal data value
A0h - exceed of upper border of input range
60h - exceed of lower border of input range

A0h and 60h codes can appear only during reg. 01h is reading by 03h function (read of a single register).

6.3. EXAMPLES OF QUERY/ANSWER FRAMES

Examples apply for device with address 1. All values are represent hexadecimal.

Field description:

ADDR	Device address on modbus network
FUNC	Function code
REG H,L	Starting address (address of first register to read/write, Hi and Lo byte)
COUNT H,L	No. of registers to read/write (Hi and Lo byte)
BYTE C	Data byte count in answer frame
DATA H,L	Data byte (Hi and Lo byte)
CRC L,H	CRC error check (Hi and Lo byte)

1. Read of the displayed value (measurement), SPT-61 device address = 01h:

ADDR	FUNC	REG H,L		COUNT H,L		CRC L,H	
01	03	00	01	00	01	D5	CA

a) The answer (we assume that the measure result is not out of range):

ADDR	FUNC	BYTE C	DATA H,L		CRC L,H	
01	03	02	00	FF	F8	04

DATA H, L - displayed value = 255, no decimal point.
Decimal point position can be read from reg. 03h.

b) The answer (if an error occur):

ADDR	FUNC	ERROR	CRC L,H	
01	83	60	41	18

ERROR - error code = 60h, bottom border of the measurement range is exceeded

2. Read of device ID code

ADDR	FUNC	REG H,L		COUNT H,L		CRC L,H	
01	03	00	21	00	01	D4	00

The answer:

ADDR	FUNC	BYTE C	DATA H,L		CRC L,H	
01	03	02	20	61	60	6C

DATA - identification code (2061h)

3. Change of the device address from 1 to 2 (write to reg. 20h)

ADDR	FUNC	REG H,L		DATA H,L		CRC L,H	
01	06	00	20	00	02	09	C1

DATA H - 0
DATA L - new device address (2)

The answer (the same as the message):

ADDR	FUNC	REG H,L		DATA H,L		CRC L,H	
01	06	00	20	00	02	09	C1

4. Read of the registers 1, 2 and 3 in one message (example of reading a number of registries in one frame):

ADDR	FUNC	REG H,L		COUNT H,L		CRC L,H	
01	03	00	01	00	03	54	0B

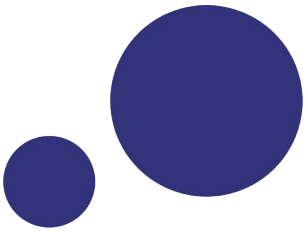
COUNT L - the count of being read registers (max.16)

The answer:

ADDR	FUNC	BYTE C	DATA H1,L1		DATA H2,L2		DATA H3,L3		CRC L,H	
01	03	06	00	0A	00	00	00	01	78	B4

DATA H1, L1 - reg. 01h (10 - displayed value ”1.0”),
DATA H2, L2 - reg. 02h (0 - no errors),,
DATA H3, L3 - reg. 03h (1 - decimal point position ” 0.0”).

There is no full implementation of the Modbus Protocol in the device. The functions presented above are available only.



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